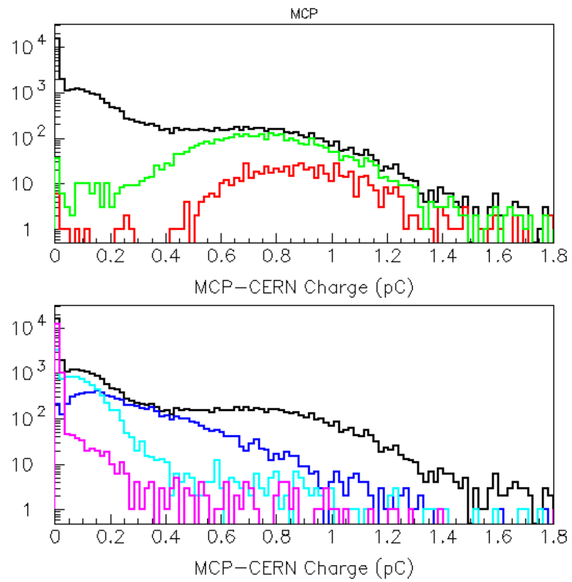
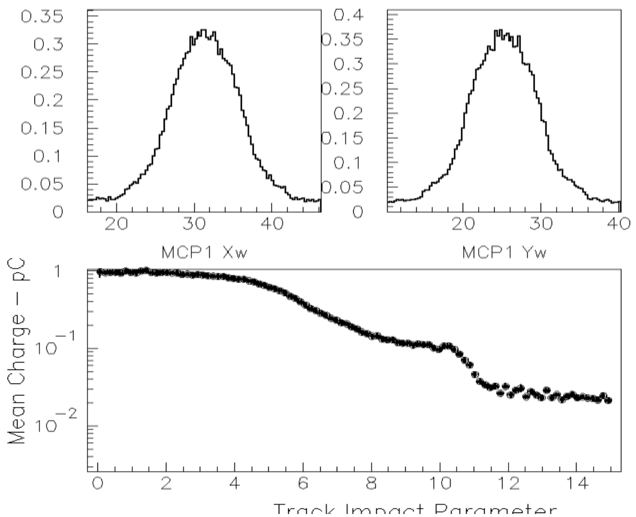
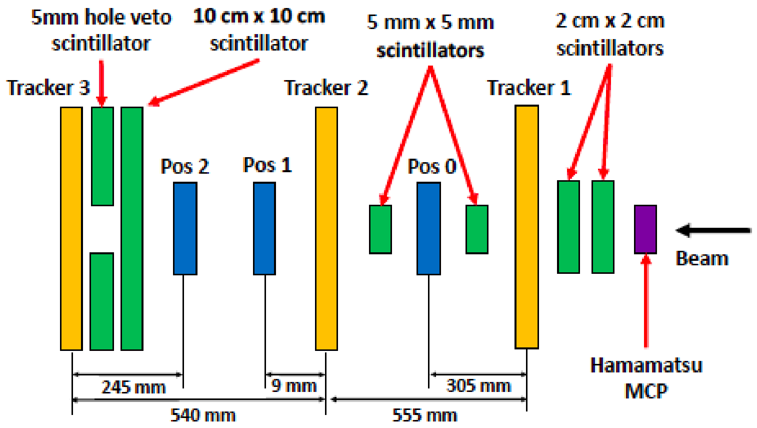
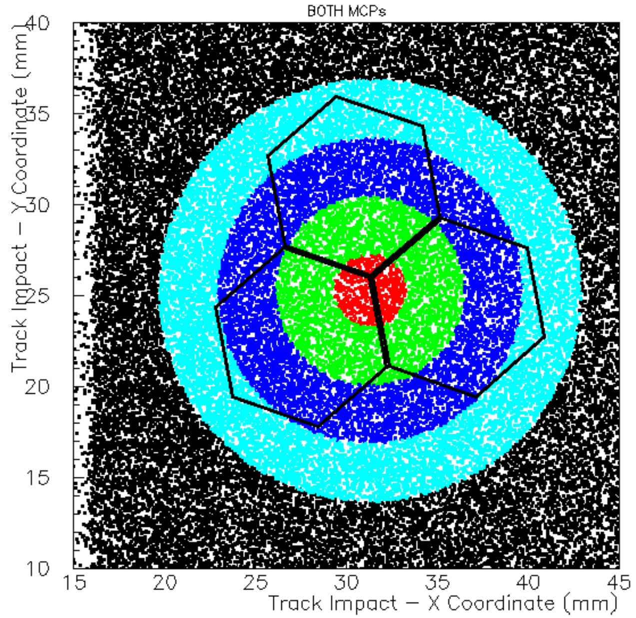
Progress Report on the multipad PICOSEC

MCP: The time reference devise

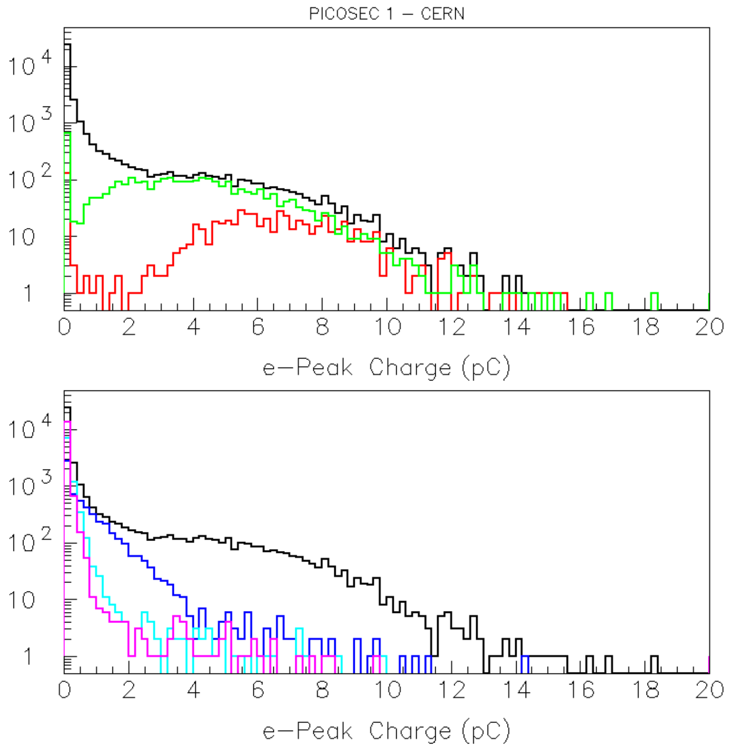


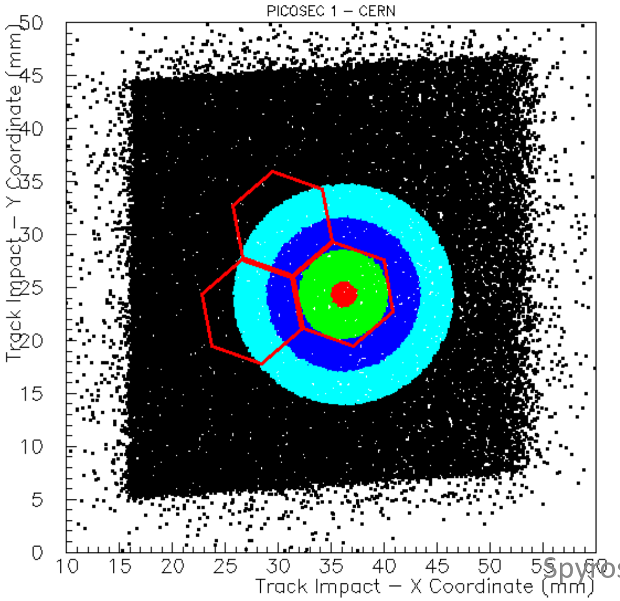


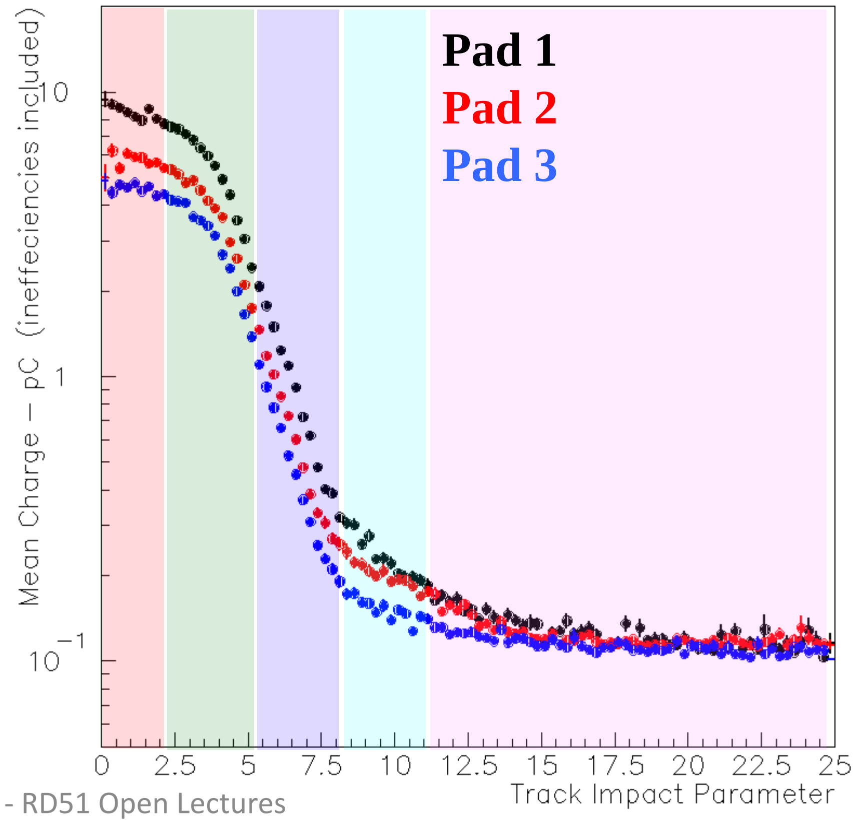




The PICOSEC PADs

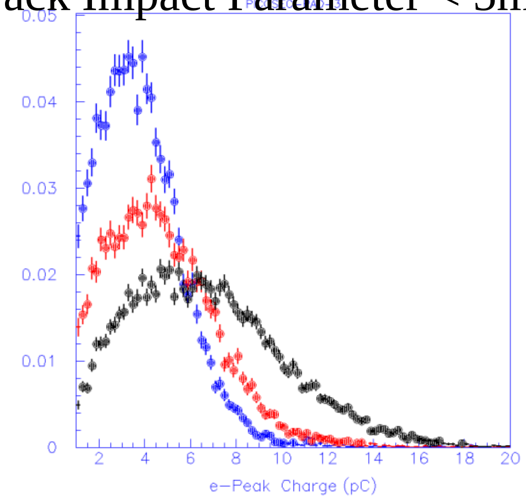




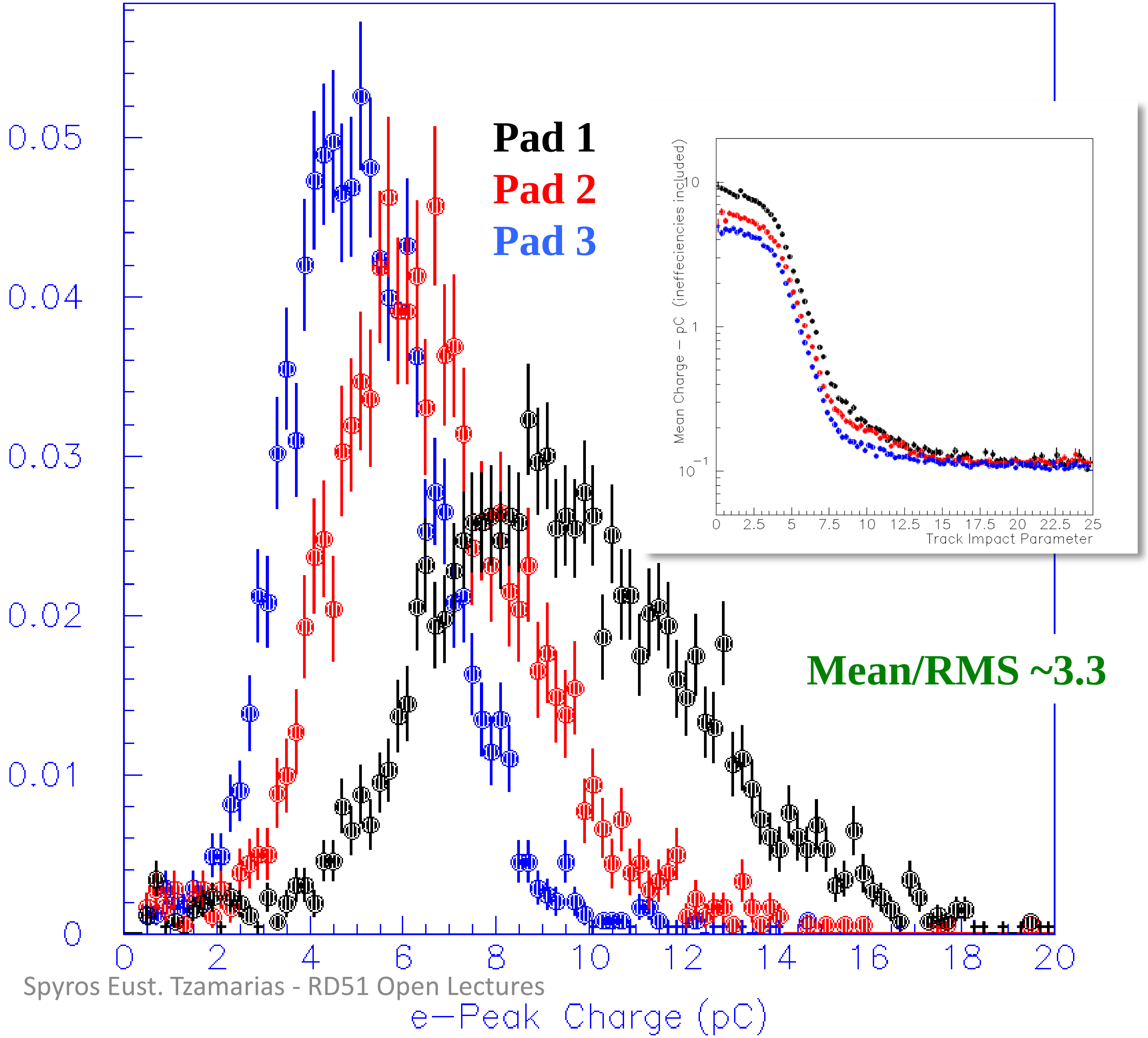


Charge Distributions

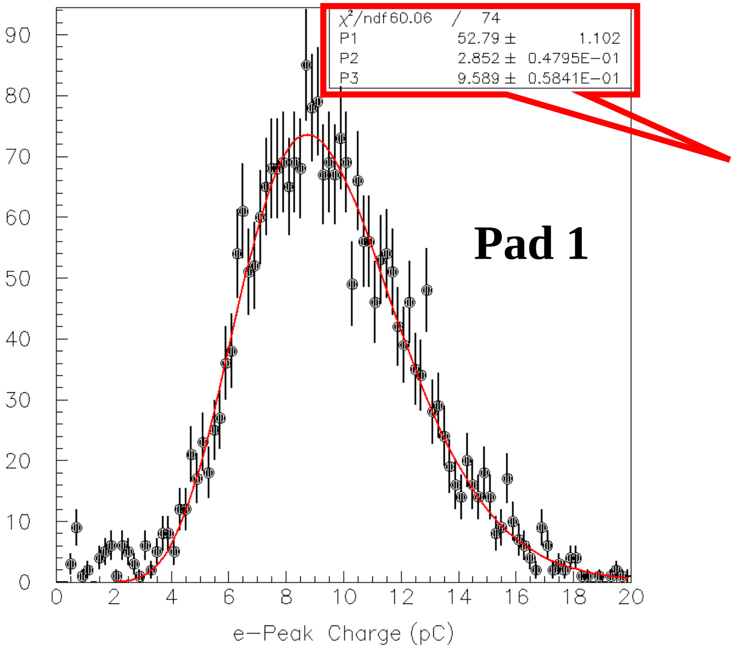
Anode area
Track Impact Parameter < 5mm



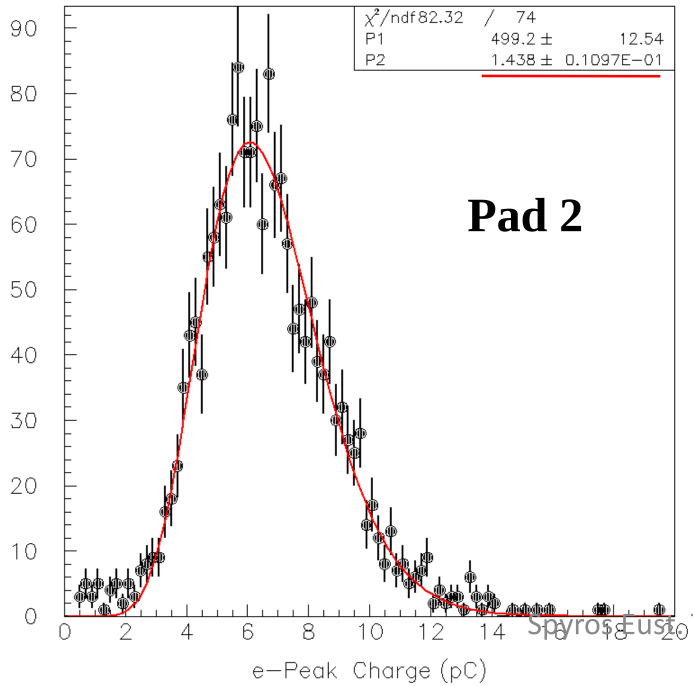
Inner Ring:Track Impact Parameter < 2mm



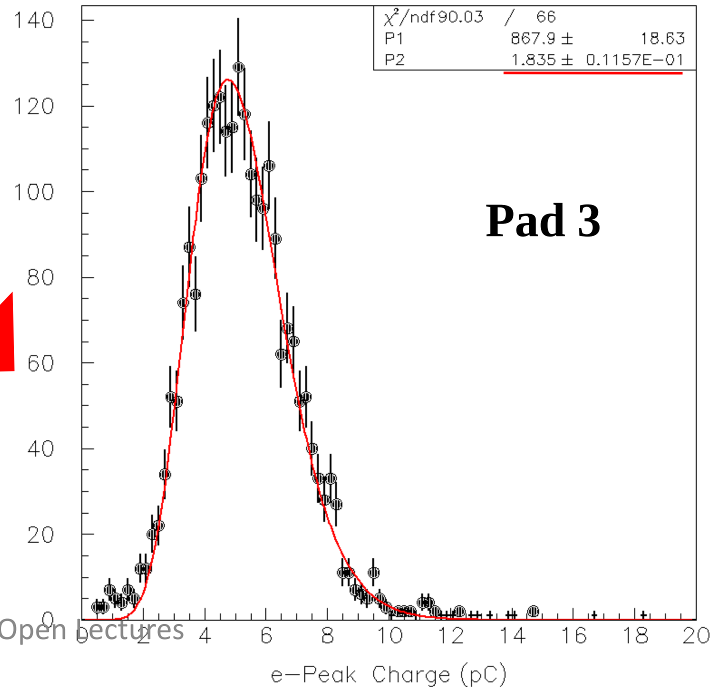
Assuming that the different PADs “charge scales” are due to external electronic gains, we could equalize the charge distributions …

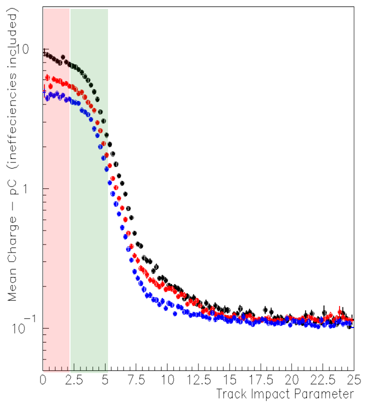


Polya Fit:
P1: RMS
P2: Mean Charge

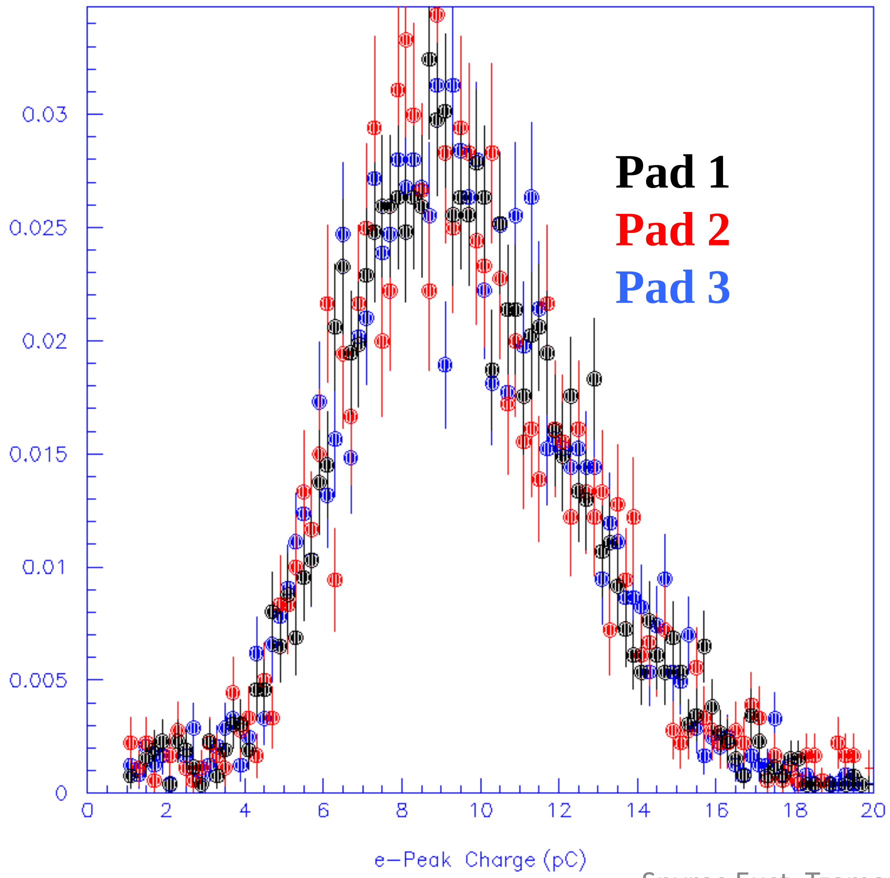


Scaling Factors

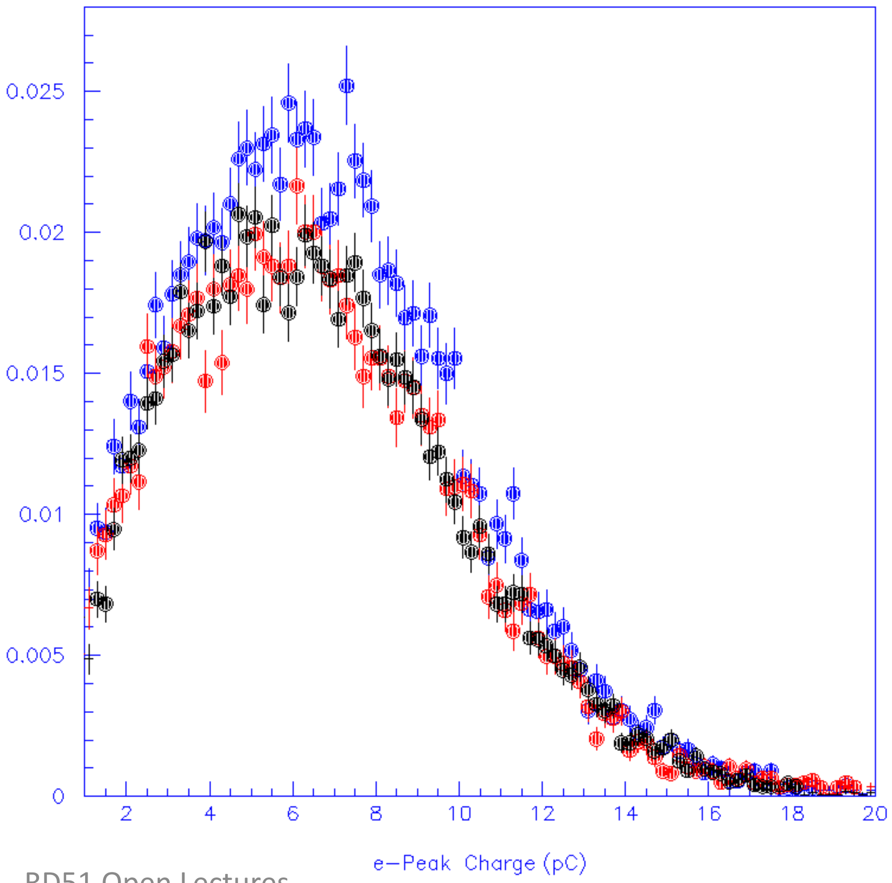




Gain Equalization (?)



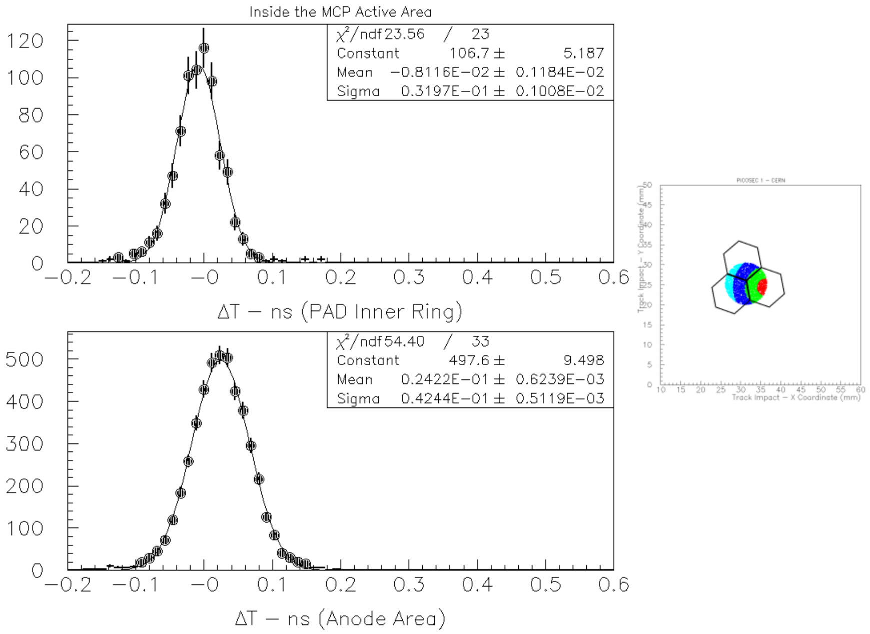
Tracks within the PAD's inner ring

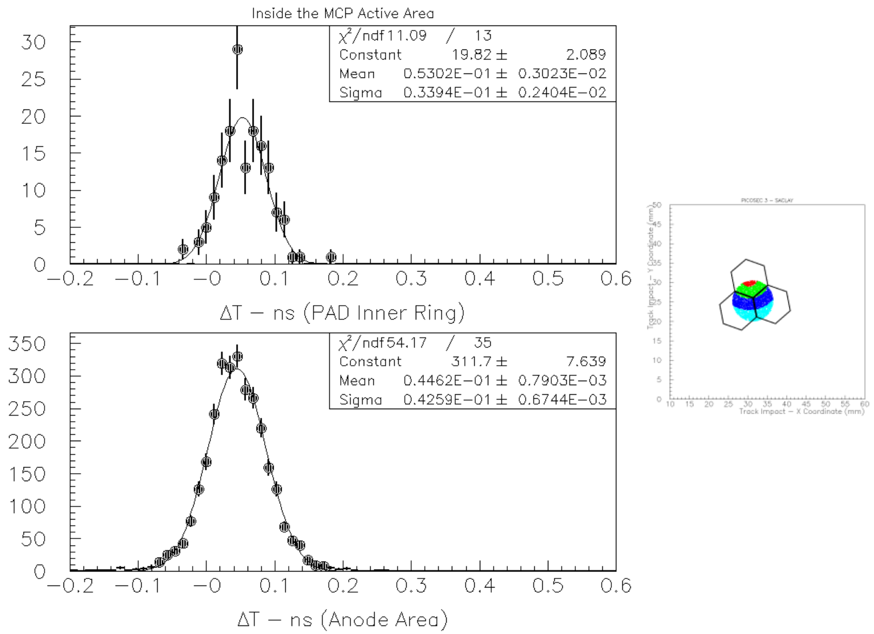


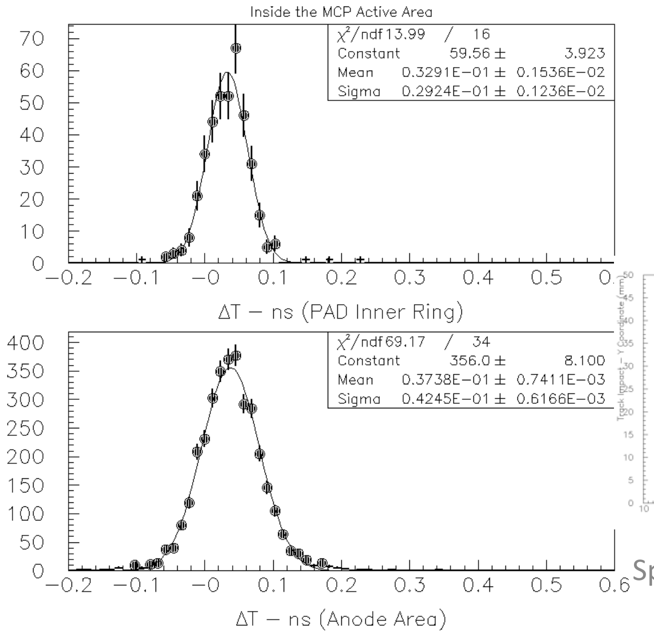
Tracks within the PAD's anode area

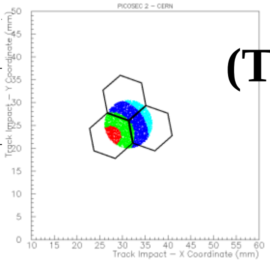
PRELIMINARY

PICOSEC Single PAD Time Resolution









Timing Resolution

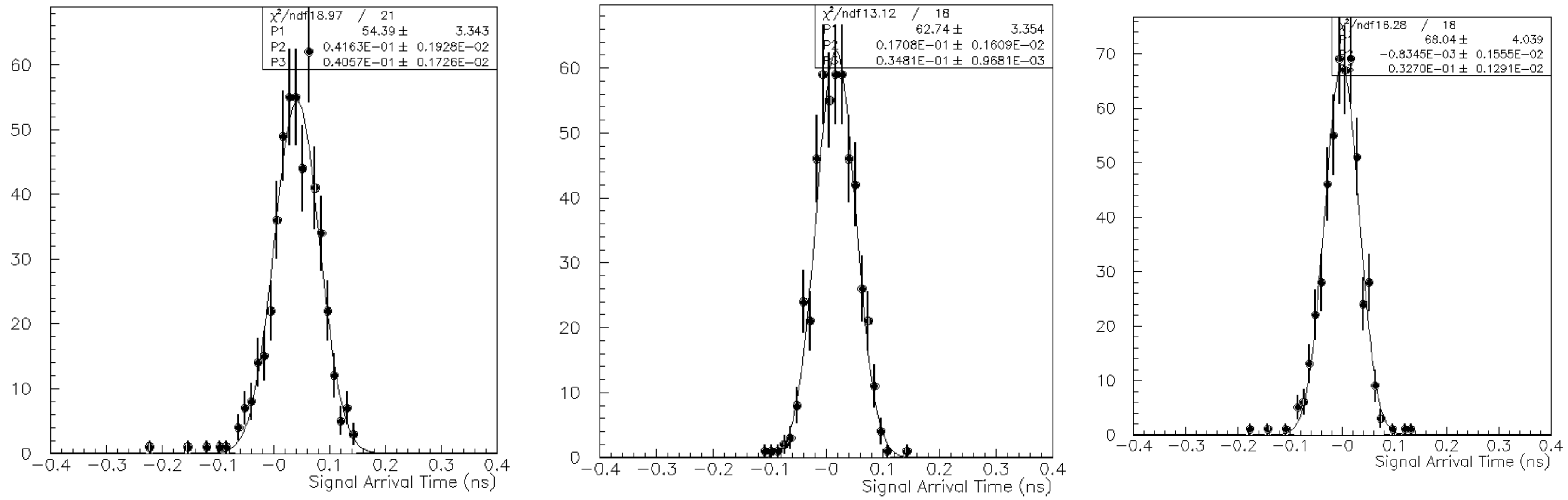
using tracks within the MCP “active area” and passing through the PICOSEC-PAD central region

~32 ps

(Tracks inside the anode area: ~42.5 ps)

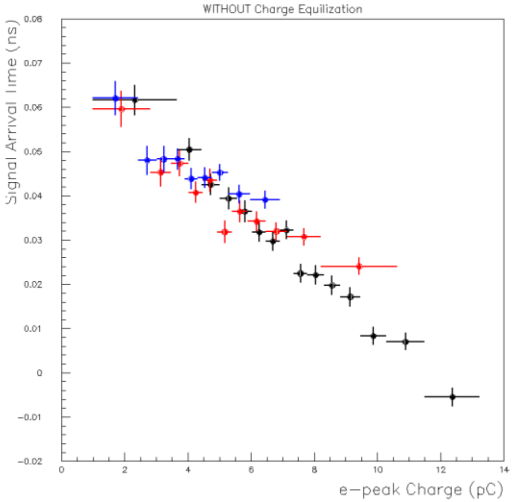
Use the timing characteristics to check the charge scaling

Estimate the mean signal arrival time and the timing resolutions in bins of the e-peak charge

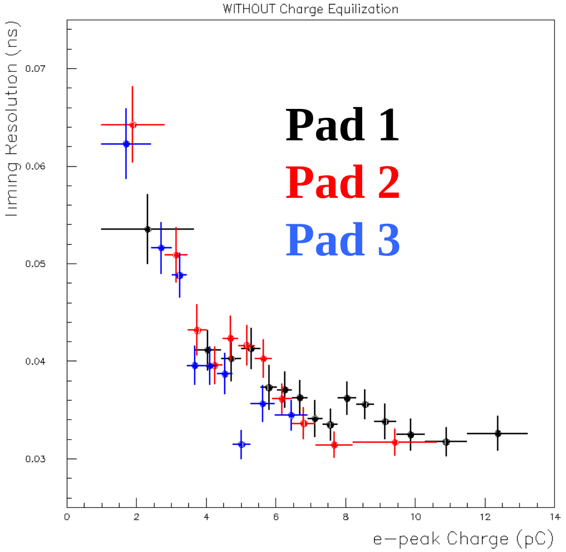


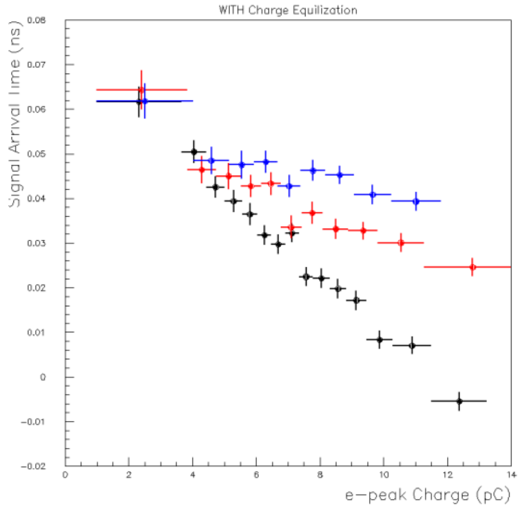
Evaluate the dependence of the mean arrival time and the timing resolution on the e-peak size, using the raw and the scaled charge.

The scaling, introduced to "equalize" the charge distributions, results to non-uniform timing characteristics !!!

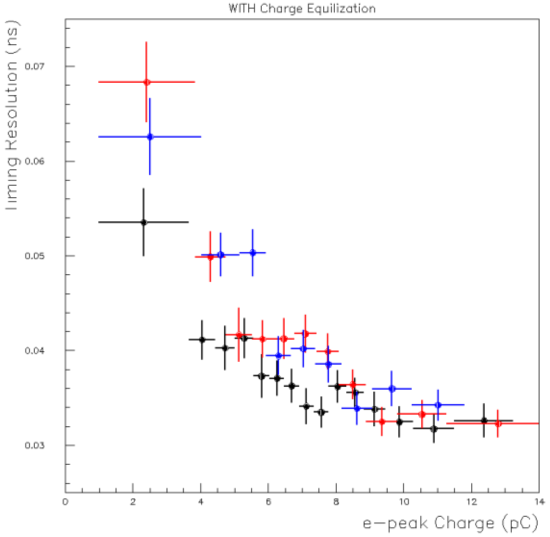


Raw Charge



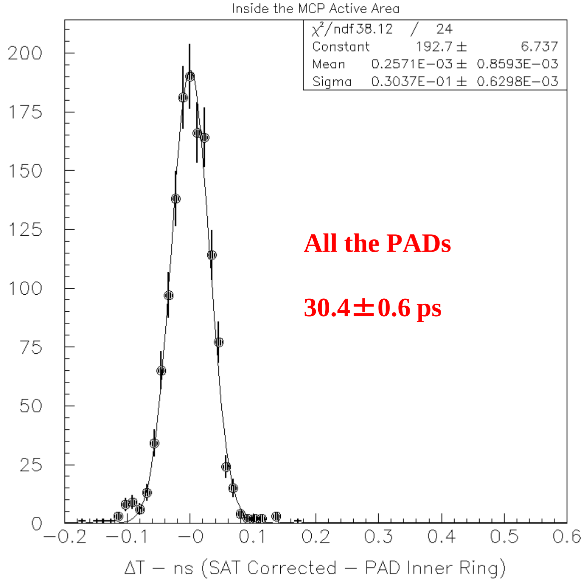


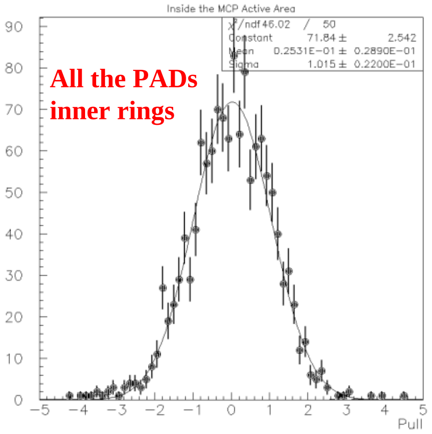
Scaled Charge

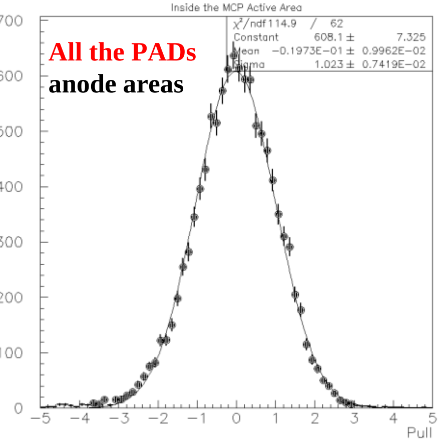


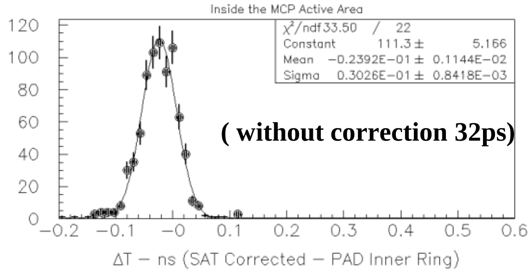
The observed difference in the charge distributions could result either from photocathode inhomogeneities or from drift field distortions or….

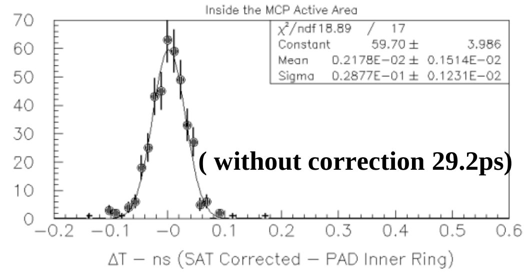
Correct the SAT estimations for dependences on the e-peak charge, synchronize pads (constant relative delays) and treat all the pad signals together. Check the pull distributions.

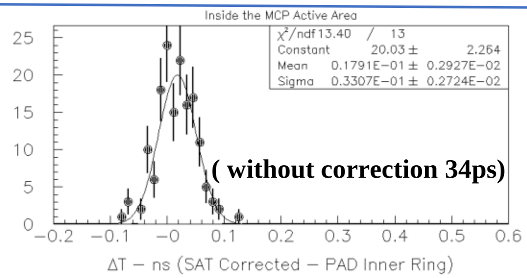


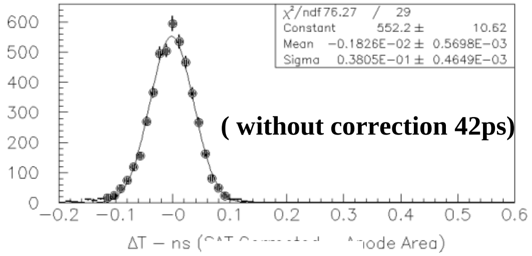


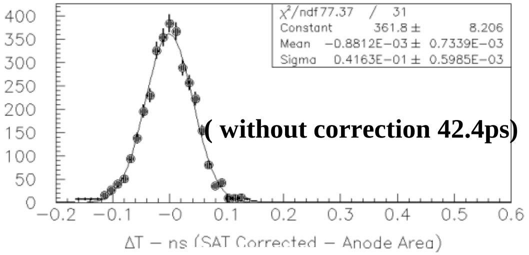


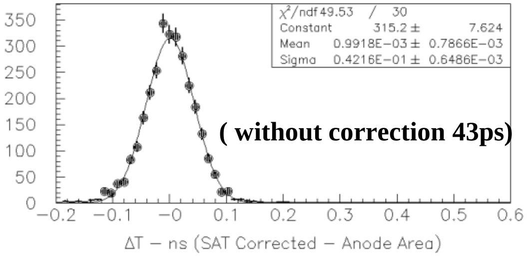


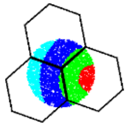


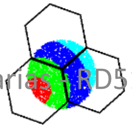


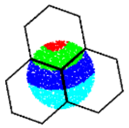




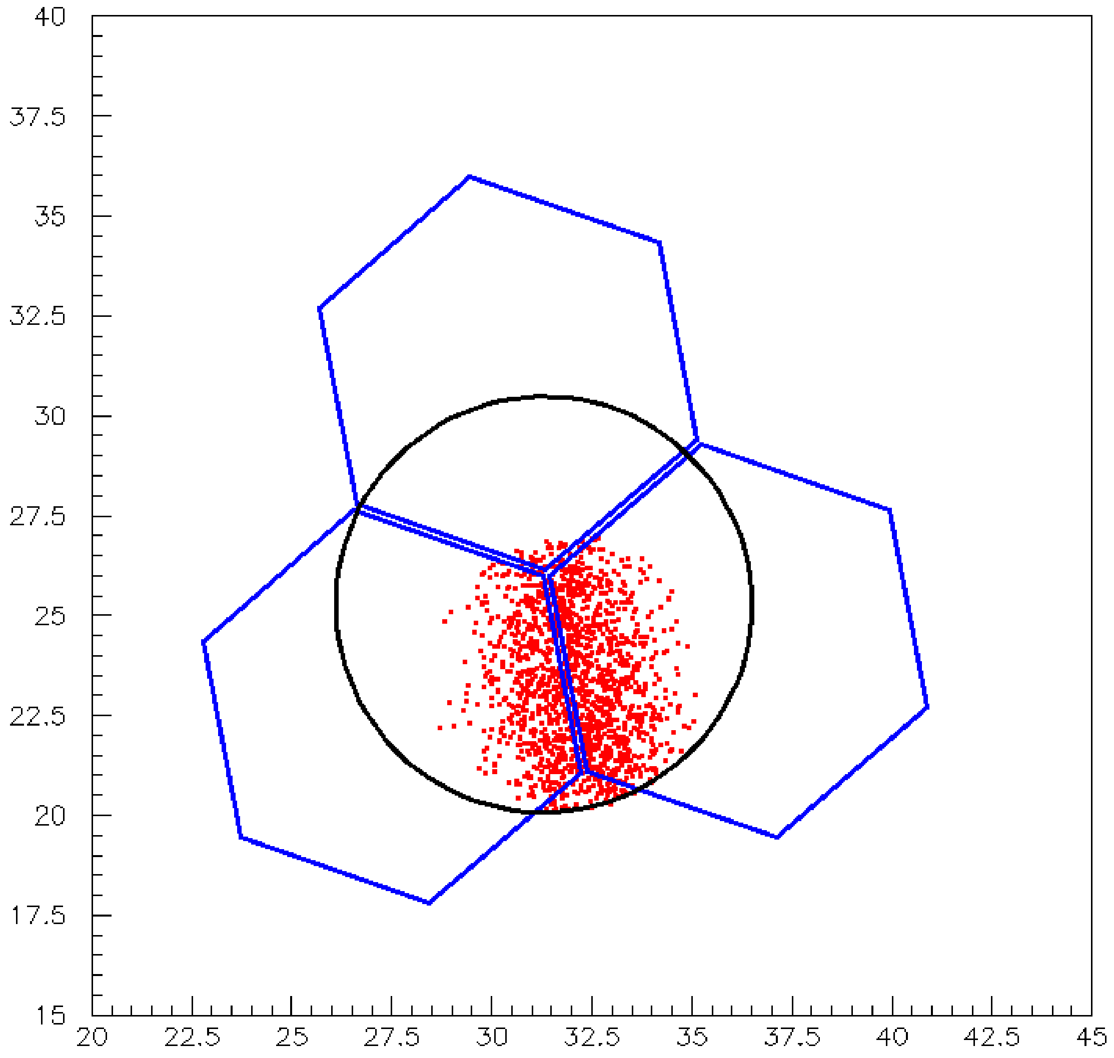




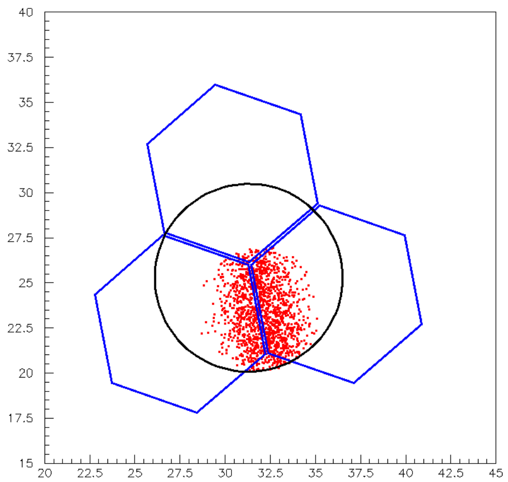


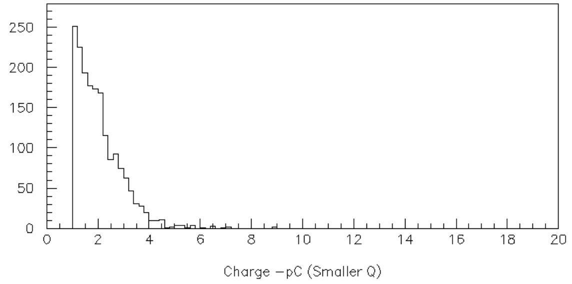


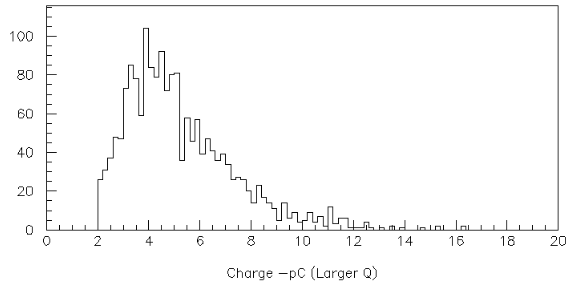
Combine the timing information from adjacent PADs
A simple exercise



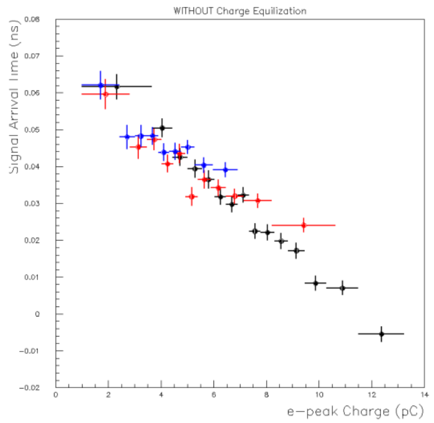
- Concentrate on tracks with impact points in the area between PADs 1 and 2
- Estimate the muon arrival time using the e-peak signal of each PAD (single PAD timing).
- Use the parameterizations, expressing the timing resolution and SAT as functions of the e-peak charge, to combine the two timing estimations

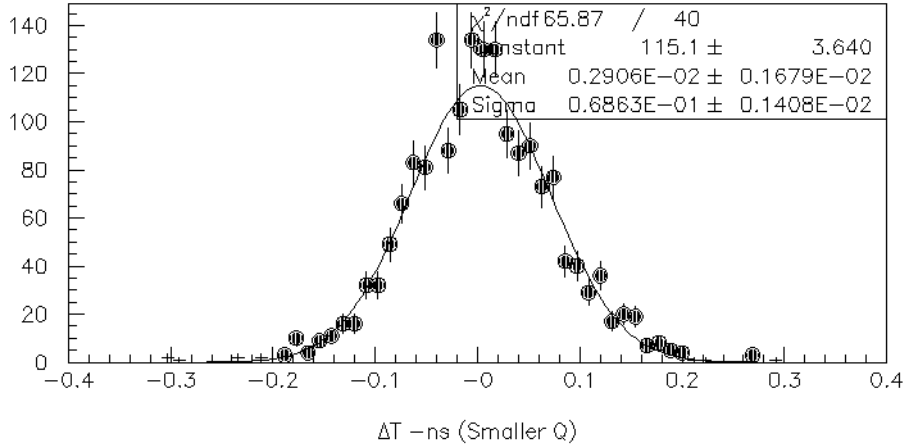


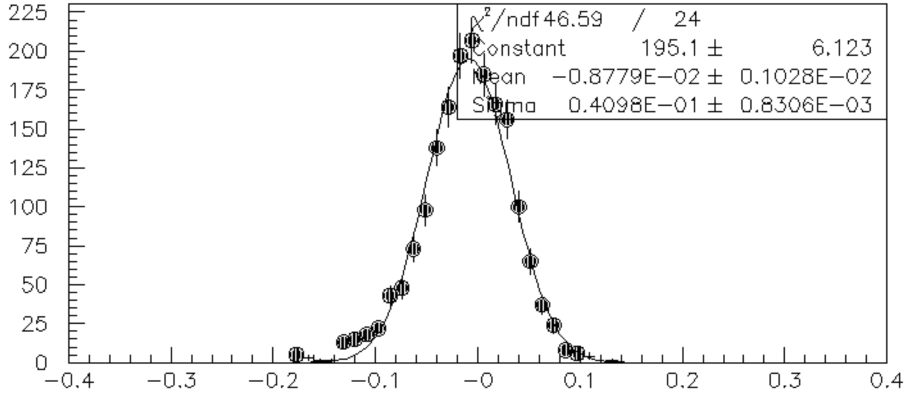




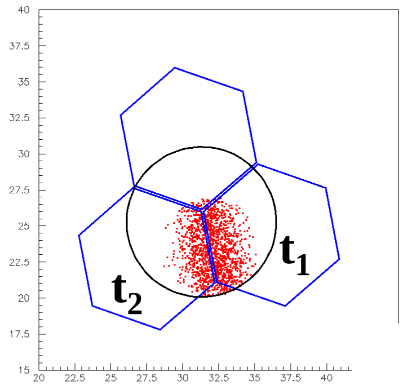
Use SAT vs Q
To "synchronize" e-peaks with different charge



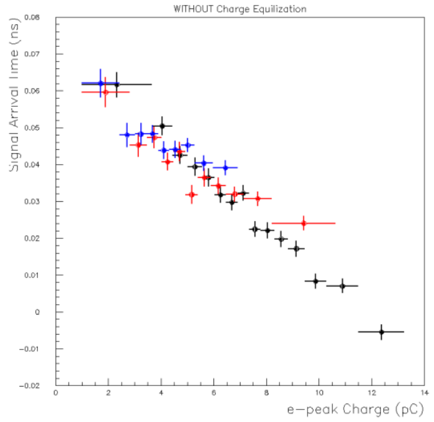




Naturally, neither of the pads achieves the optimum timing resolution, i.e. the timing resolution when all the produced photoelectrons are detected by the same pad



W(Q)

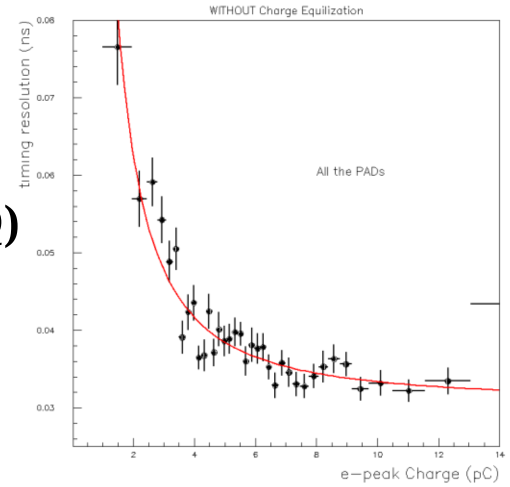


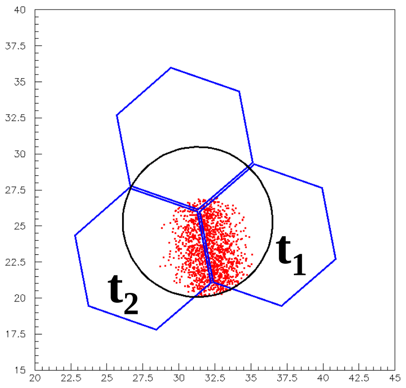
$$\chi^2 = \sum_{i=1}^{2} \frac{\left(\hat{t} - t_i + W(Q_i)\right)^2}{\left(R(Q_i)\right)^2}$$

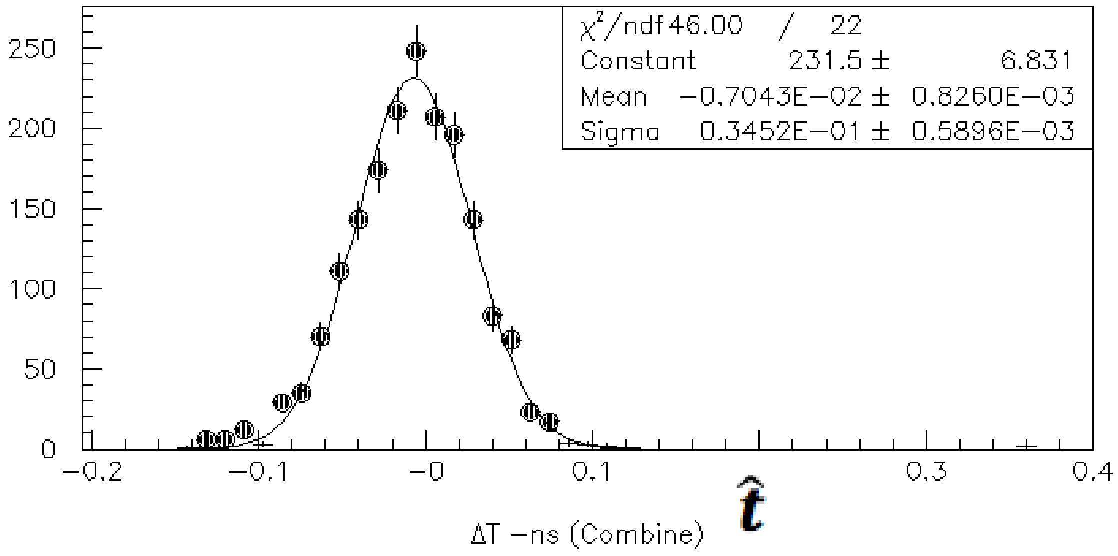
$$\hat{t} = \frac{\sum_{i=1}^{2} \frac{\left(t_i + W(Q_i)\right)}{\left(R(Q_i)\right)^2}}{\sum_{i=1}^{2} \frac{1}{\left(R(Q_i)\right)^2}}$$

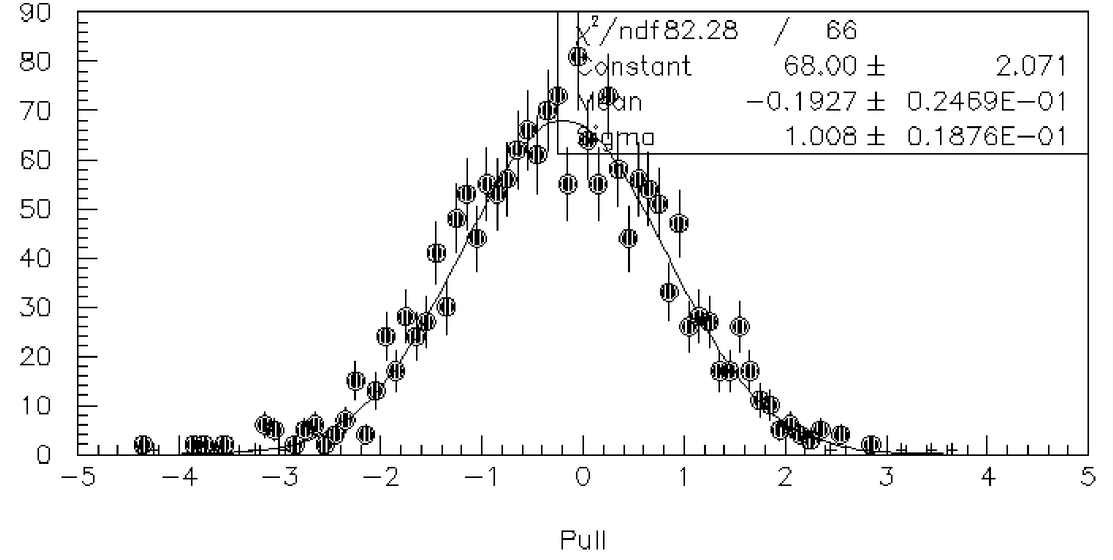
$$\delta_{\hat{t}} = \sqrt{\frac{1}{\sum_{i=1}^{2} \frac{1}{\left(R(Q_i)\right)^2}}}$$

R(Q)









The weighted average of the two timing information almost recovers the optimum timing resolution